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*Editorial Comment*

# Are the Benefits of the Automatic Implantable Cardioverter-Defibrillator (AICD) Overestimated by Sudden Death Rate?*

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**The AICD.** In this issue of the Journal, Kim et al. (1) describe a cohort of 56 consecutive patients who received an automatic implantable cardioverter defibrillator (AICD) over an 8 year period for treatment of sustained ventricular tachycardia (37 patients) or ventricular fibrillation (19 patients). In their series patients who received an AICD for malignant ventricular arrhythmias had a low sudden death rate (only 8% at 3 years). However, on the basis of other analyses, they contend that this low sudden death rate is a substantial overestimation of the actual success rate for the AICD (8% sudden death rate vs. actual 15% "arrhythmic death" rate at 3 years).

Michel Mirowski pioneered the AICD (2,3). He hypothesized and now has proved that an implanted device such as the AICD or ICD can detect and convert malignant ventricular arrhythmias, thereby saving the patient from sudden death. The effectiveness of this device is now unquestioned (2–5) as Kim et al. (1) indicate; however, they (1) advise that operative death and death "a short period of time" after successful AICD shock should be considered "arrhythmic death."

**Defining subsets of sudden death.** Kim et al. (1) define several subsets of death. As they and other clinical investigators are aware, it is difficult to classify death into strict categories (sudden vs. nonsudden death, for example). They expand the definition of arrhythmia-related death to include operative death and "arrhythmia-related nonsudden death."

Defining death in patients with an AICD is uniquely difficult. Because the incidence of sudden death is low in these patients and many "appropriate" shocks are delivered (generally 50% of patients with an implanted device), it is clear that the AICD does prevent sudden death from ventricular tachycardia. When the successfully implanted device has been adequately tested and when the cardiac arrhythmia substrate remains unchanged and there are no intervening factors, such as stroke, myocardial infarction or complete heart block, a functional AICD appears to achieve the goal of preventing sudden death from malignant ventricular arrhythmia nearly 100% of the time.

**Mechanisms of death.** Steinman et al. (6) determined from 24 monitored sudden deaths in patients with an AICD that three patients had demonstrated electromechanical dissociation (bradycardic death) and four patients had their AICD deactivated (three postoperatively). In their review (6), 3 of 15 patients with terminal ventricular tachycardia or ventricular fibrillation had a >20 J threshold and 4 others did not undergo operative ventricular fibrillation-cardioversion testing and had only ventricular tachycardia testing. Thus, many of their patients with an AICD die suddenly without device failure. An impressive 53% of patients who died experienced a prior AICD discharge thought to be related to ventricular tachycardia or ventricular fibrillation before their eventual sudden death. Although sudden death was eventually not prevented, the AICD itself may not have failed. Kim et al. (1) did not indicate how many of their patients had appropriate discharges before their eventual sudden death. It may be that several of their patients with sudden death had had their life extended even though they died suddenly with an AICD in place.

Thus, determining the exact cause of death and sudden death becomes increasingly difficult in patients with an AICD. In fact, the sudden death rate may underestimate the effectiveness of the AICD. We should not consider that all sudden deaths in patients with an AICD are a result of device failure even though the prescribed therapy proves inadequate.

Conversely, nonsudden cardiac deaths can be causally related to arrhythmia. Because of the low incidence of operative death in patients with an AICD and the small number of patients in available series, the stratified risks of operative death are unclear. In the series of Kim et al. (1), one patient died of progressive pump failure and one of multiple sustained ventricular tachycardia events after AICD implantation. In neither case was the device itself a failure, yet the intended AICD treatment was causally related to death. In another patient, cryosurgery failed and the patient died postoperatively after multiple episodes of ventricular arrhythmia. A "bailout" AICD for primary surgical failure might arguably not be considered death causally related to the AICD.

**Complications.** The early and late complications specifically related to the AICD include operative death (in most series, 3% to 4%), inadequate defibrillation threshold (1%), early infection (generally requiring explantation) (1%) and

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other unusual events. Thus, approximately 5% to 6% of patients have an unsatisfactory operative outcome from AICD implantation. Thereafter, late infections (0.5% to 1% per patient-year) and premature battery depletion can adversely affect the patient after successful implantation. Unsatisfactory surgical outcome may reasonably be added to the approximately 2% 1 year risk of sudden death for a total 8% 1 year poor outcome of intent to treat with an AICD.

**Conclusion.** We conservatively suggest that a >10% 1 year risk rate of sudden death from ventricular tachycardia or ventricular fibrillation is the appropriate incidence for which AICD therapy should be considered. It is true that the simple sudden death rate overestimates AICD benefit. However, improved operative risk stratification and implantation techniques combined with improved device monitoring and function will probably reduce that overestimation. Despite several shortcomings of AICD therapy, it remains the standard for prevention of sudden death in patients with ventricular tachycardia or ventricular fibrillation.

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